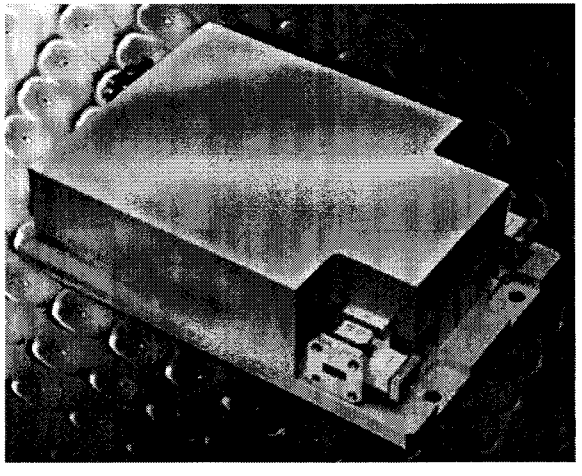
DEEP SPACE 1

Ka-band Solid State Power Amplifier



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Outline

- Introduction
- DS1 Telecommunication Subsystem Description
- KAPA Description and Flight Qualification
- KAPA Flight Validation
- Acknowledgments

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Introduction

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Importance of Ka-band

- 6 to 8 times in performance improvement (downlink data rate) over X-band (8.4 GHz).

  Faster return of science data allows for shorter mission operations (saving project funds). Enables greater data volume return.

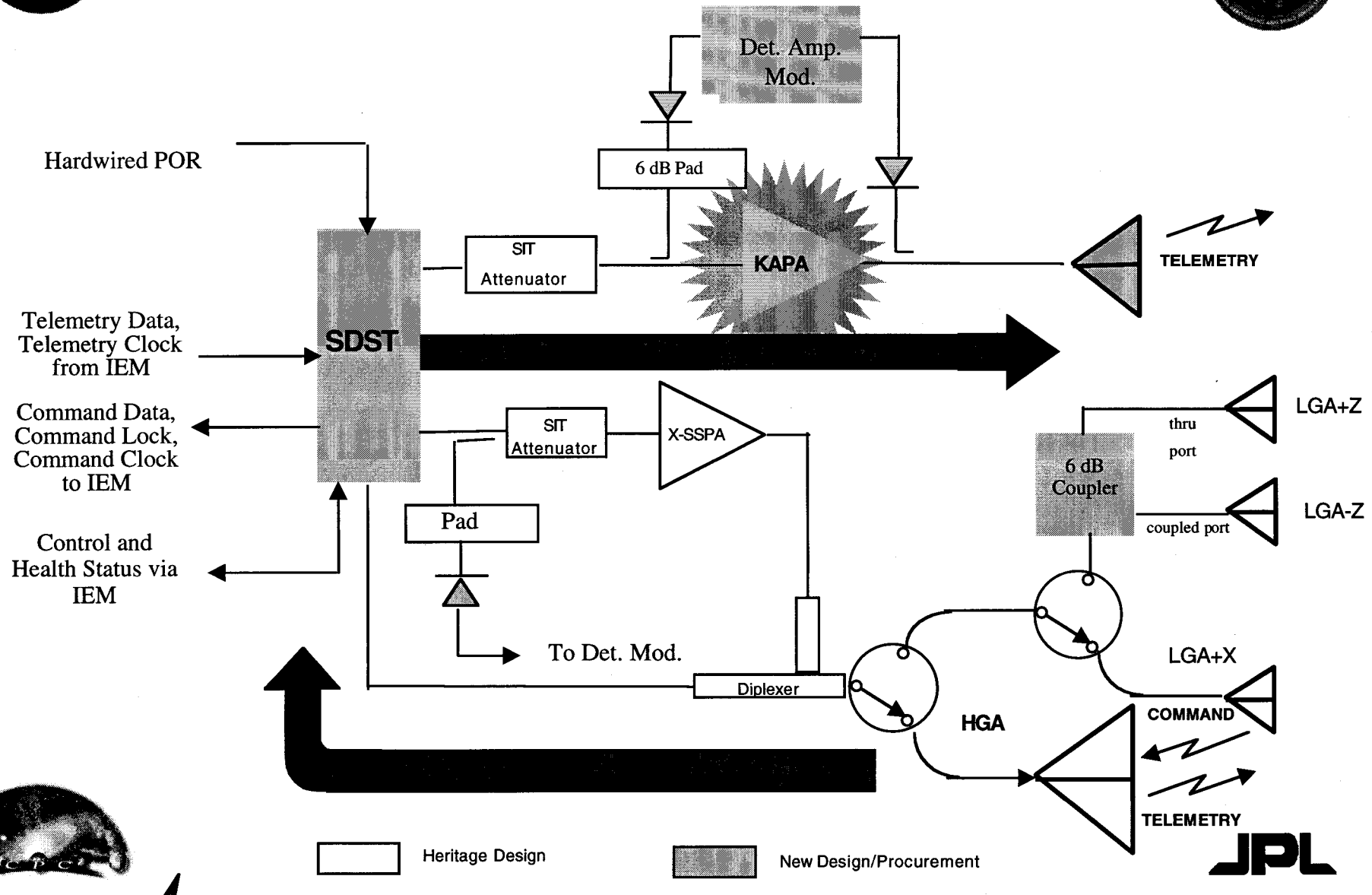
- The commercial community is employing higher frequencies for communications and this allows for synergy between their IR&D and NASA advanced technology development.

- Important for radio science applications (e.g. gravity wave)

- Lower subsystem mass and volume since components are smaller than X-band. In particular, antenna size can be reduced since the electrically we get higher gain for a given fixed aperture. Therefore, designers can choose higher downlink data rates or smaller antenna size.

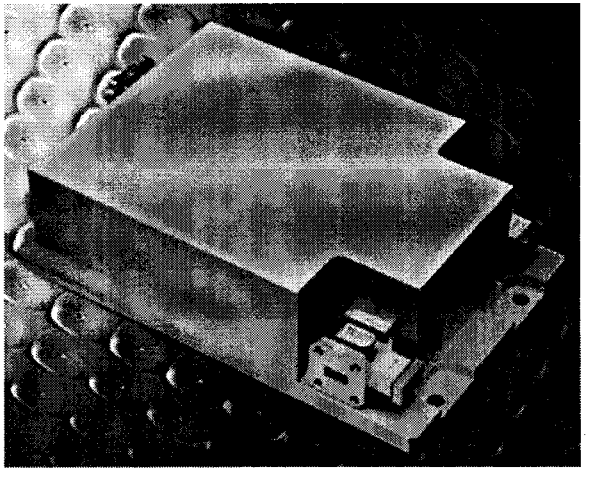
  Lower mass/volume helps to move toward the use of smaller launch vehicles which saves project cost.

Telecommunication Subsystem Block Diagram



Key KAPA Features

- RF Power 2.2W Ka-band (32 GHz)
- Power Added Efficiency = 12.5%
  (0.25 μm GaAs PHEMT technology)
- Unit mass: 0.66 kg
  (including power converter)
- Unit RF gain: 37 dB
- Protoflight qualified to DS1 levels
- Internal telemetry (two gate currents, output drain voltage and temperature). In addition, JPL has provided additional telemetry channels for input power, output power, unit temperature (even when powered off), and total current.



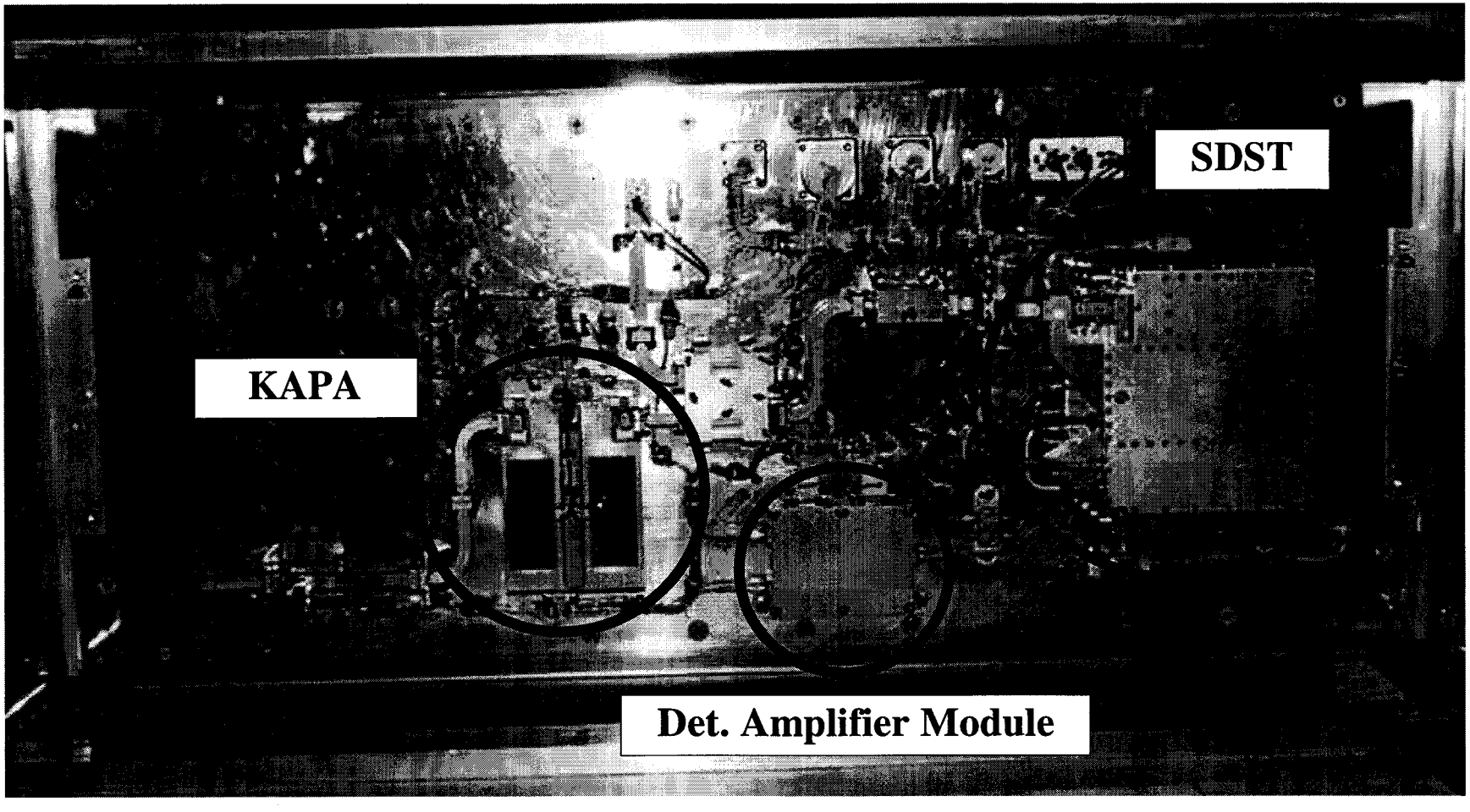
KAPA Qualification

- Random Vibration-

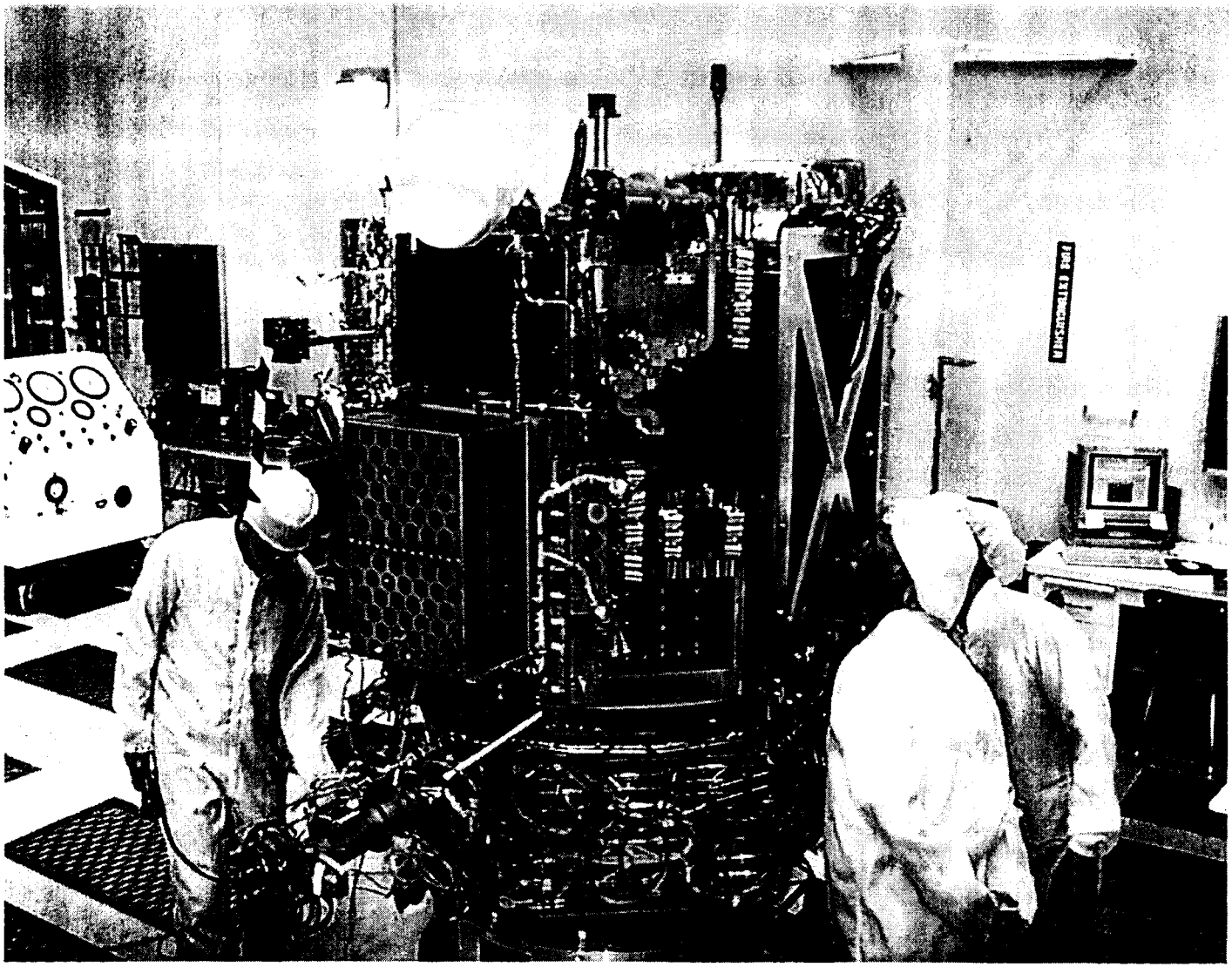
20 Hz	0.0322 G^2/Hz
50-500 Hz	0.2 G^2/Hz
2000 Hz	0.0126 G^2/Hz
Overall	13 G_{rms}

- Thermal Vacuum cycling from -14°C to +40°C
- Full EMC testing to tailored MIL SPEC 461

Subsystem Integration



DS1 Spacecraft



Summary of KAPA Flight Validation

Pre-Launch

Parameter	Achieved	Benchmark (MGS Mission)
Mass*	0.650 kg	>0.600 kg (does not have input isolator)
RF Output Power	2.2W	1W
Efficiency*	13%	8.7%
Gain	36.4 dB	15 dB

Post-Launch (>L+25)

Parameter	Achieved
RF Output Power	2.16W
Efficiency*	12%
Gain	36 dB

*including DC-DC converter

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Summary of KAPA Flight Validation (continued)

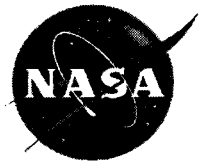
Operational Ground Time: 250 Hours (both vacuum and atmosphere, not hermetically sealed)

Operational Flight Time: 1680 hours

Flight Power Cycles: 28

Demonstration of Ka-band capability*:
Deep Space Communications
Radio Navigation

* Details of Ka-band performance are linked with the SDST technology validation demonstration (described in the previous paper by C. Chen).



Acknowledgments

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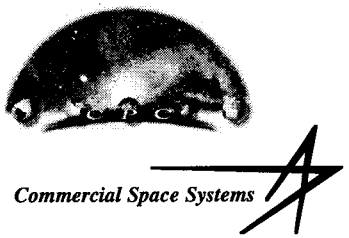

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Summary

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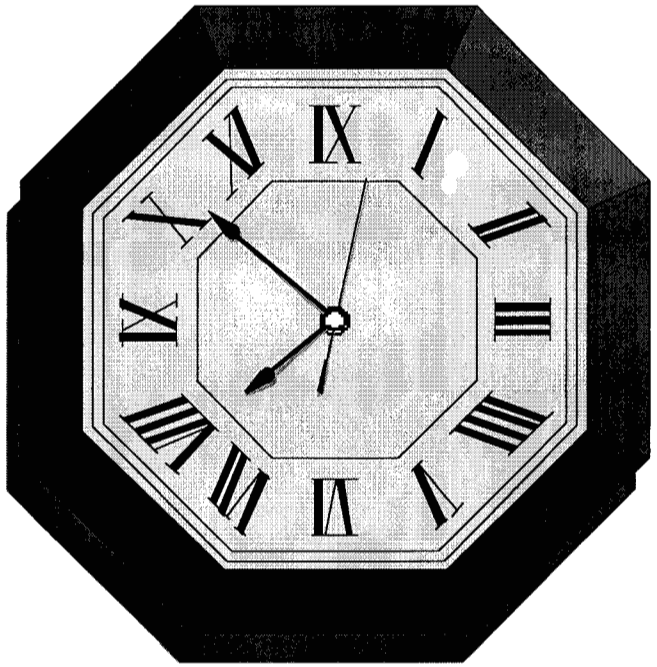
- Highest power solid state Ka-band amplifier demonstrated for a Deep Space mission.
- KAPA enabled further validation of the Ka-band advantage over X-band for Deep Space Communications.
- DS1 was the first mission to use Ka-band in an operational mode within the DSN (versus the research antenna DSS-13).
- Successful demonstration of NMP collaboration (working with industry to flight new technology without exchange of funds).



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